

## MODULE 2: ASSESSING THE ENVIRONMENTAL RESULTS OF THE INNOVATION

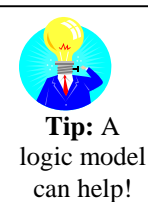
Module 1 asks the innovation practitioner to describe the logic of the innovation, and the logic model process describes the relationship between the goals, activities, outputs, and outcomes of the innovation. This module is intended to help the practitioner identify the environmental goals of an innovation, link environmental outcomes to those goals, identify appropriate performance measures, determine methods for measuring results, and measure the results of the innovation. The term *environmental results* is intended to include output measures (e.g., number of facilities committing to a reduction in greenhouse gases in a voluntary program or number of permits issued), outcome measures (e.g., percent reduction of greenhouse gases over the baseline), and environmental indicator measures (e.g., air monitoring data that indicates improvements in air quality).

Innovation analysis often falls short on identifying environmental performance measures, tracking environmental indicators, and measuring environmental outcomes. **Performance measures** are usually designed at the start of the innovation and track with the goals of the innovation. For example, if the innovation is an environmental technology, an example of a performance measure for the innovation is 50 percent adoption of the innovation within two years. **Environmental indicators** help measure the state of our air, water, and land resources, the pressures on them, and the resulting effects on ecological and human health. An example of an indicator measure is the number of people living in areas with ozone (8-hour) and particulate matter levels above the National Ambient Air Quality Standards. **Outcome measures** look at the extent to which the innovation is achieving its intended results. For example, EPA's programs should have long-term environmental outcomes of improving public health and the environment and quantifiable health and environmental measures to show if EPA is reaching its goals. The logic module in Module 1 asks the innovator to think of outcomes in short-term horizons (i.e., a change in attitude or acquisition of knowledge), intermediate outcomes (i.e., a change in behavior), and long-term outcomes (i.e., a change in condition).

Environmental results may also include the benefits of having a cleaner environment, which can be classified into three types of benefits: 1) human health, 2) ecological, amenities (i.e., taste, odor, visibility), and 3) reduced environmental damages (e.g., reduced runoff). Such environmental results should be identified and, to the extent feasible, described quantitatively. In situations where quantification is not possible, the innovation practitioner should qualitatively describe the benefits.<sup>1</sup> Results also may include or be dependent on behavioral changes that the innovation may be trying to address. Behavioral changes can also be described in this section, however they may be described at different qualitative levels (e.g., anecdotal evidence versus a survey) depending on the analytical rigor necessary for the innovation.

### *Design Phase*

For innovations in the planning phase of the innovation life cycle, evaluators should be able to identify goals, develop appropriate measures to assess whether the innovation is meeting its goals, and *anticipate* environmental outcomes. Often, the hardest part of designing an innovation is choosing appropriate measures to describe the intended outcomes of the innovation. Many innovations stop at the measurement of outputs of the innovation (e.g., number of permits issued or number of inspections completed), especially in the design phase. The innovation practitioner should have an eye to linking the output measure to the outcome measures for intended or expected outcomes (e.g., 10 percent reduction in emissions from permitted sources).



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<sup>1</sup> This module is not intended to result in a valuation of benefits that would occur in the context of a formal benefit-cost analysis. Instead, the analyst will assemble available information and use it to guide the development of the innovation.

### *Implementation Phase*

For innovations in implementation (depending on how long the innovation has been implemented), innovators should be able to measure and report results as to whether environmental outcomes are meeting or exceeding expectations when compared to the baseline measures. In addition, innovators should look at collecting and reporting qualitative and quantitative information needed to explain if and how well the innovation is working. During implementation, this module may be used to re-check the data measurement and collection approach depending on the results. A mid-course analysis may reveal a data gap or incomplete data collection. The innovator may have to decide what the impact of a data gap is on the long-term course of the innovation and whether the data should be collected mid-stream.

### *End of the Innovation Phase*

For mature innovations, the innovator should demonstrate if and how the innovation poses a relative advantage over the traditional approach in terms of environmental results. This module explores possible differences between anticipated results and actual results in order to ascertain if and why, the innovation may or may not be working as intended. For an innovation to succeed and possibly be replicated, qualitative information as well as quantitative data on environmental outcomes is needed.

### *Formal Evaluation*

The practitioner should focus on how the results were achieved and if a causal link can be made between the innovation and the results. The evaluation should address how the innovation caused the intended outcomes to be realized. If the outcomes were not realized, the evaluation should focus on why they were not realized and how the innovation should be modified or improved to realize outcomes in the future.

This module concentrates on environmental results in contrast to process efficiencies such as permit streamlining that make more efficient use of Federal, State, or local resources. Such efficiencies could be addressed in Module 3: Assessing Costs and Cost Savings of Innovation. Process efficiencies may result in greater environmental protection because scarce resources are able to focus on other environmental problems, but it may be difficult to track these connections and to determine a cause and effect relationship.

## **I. Identifying Environmental Goals of the Innovation**

In Module 1, the practitioner identified the problem(s) that the innovation was designed to target and asks the user to identify outcomes for the innovation in a logic model. Module 2 asks the practitioner to identify the environment goal or goals that innovation intends to achieve relative to the problem that the innovation is trying to solve. The innovation practitioner should ensure that the stated goals appropriately match in size and scope, the nature of the environmental problem that the innovation is trying to solve.

1. What are the specific **environmental goals** that the innovation is intended to achieve? Please describe.
2. Do the goals of the innovation match the problem(s) that the innovation is trying to solve? (Related to Module 1)
3. Do the goals of the innovation match the expected/intended outcomes of the innovation? (Related to Module 1)
4. Do the goals of the innovation include **cross-media transfers**? If yes, how many and what types of cross media transfers are being considered?

## **II. Measuring the Environmental Results**

In order to make sound judgments about the potential benefits of the innovation, the practitioner needs to measure the results of the innovation when compared to the current practice. That is, compare the current state of the world (or world without the innovation) to the one in which the innovation is in effect—this determines whether the innovation is achieving its intended outcomes. If the user is in the Federal

Government, measurement is also central to reporting obligations under the Government Performance and Results Act (GPRA). The practitioner can adapt the questions in the module to address the GPRA reporting requirements as well as any other reporting requirements specific to the innovation. The next section includes the overview questions, a discussion of the issues to consider in answering each question, how to design performance measures, and examples of how data might be organized to measure environmental impacts.

**Measurement Approach.** A measurement approach is the method(s) that will be used to collect data and information on the innovation. For example, the innovation practitioner may decide to use focus group interviews to collect qualitative data on the efficiency of the innovation and can use air-sampling data to collect data on the efficacy of the innovation. The practitioner must determine what measurement approaches are feasible based on the available data – quantitative, qualitative, or anecdotal – and the needs and resources of the innovation team. They are more likely to have greater flexibility at the design phase to choose the appropriate measurement approaches than if the innovation is already being implemented.

The availability of quantifiable environmental results depends on the type of intervention of the innovation. For example, where an innovation results in a change in the level of emissions or discharges that are already being monitored and tracked for regulatory purposes, it will be easier to access data (e.g., permitted source will already be monitoring and tracking emissions through stack tests). If an innovation is aimed at an environmental problem for which there exists little or no data (e.g., non-point source pollution for certain pollutants), it will be more difficult to quantify the level of improvement directly related to the innovation, through environmental indicators.

Qualitative and anecdotal data can support an innovation and may be necessary to make the case for transferability of the innovation. For example, in the case of a health benefit, it may be possible to qualitatively assert that the innovation is expected to be a contributing factor to a reduced incidence of asthma in children without establishing a direct correlation between the innovation and the reduced incidence. Anecdotal data also provides information on how people perceive the innovation to be working. An example of an anecdotal use of information might be where a regulatory agency is testing the merits of an Internet-based public participation process and stakeholders are asked informally to provide feedback because it is not feasible to conduct a statistically valid survey.

NOTE: If the user is in the Federal government, there are restrictions under the Paperwork Reduction Act on surveys and questions that the Federal government can ask of non-Federal entities or persons. For more information on survey/interview limits of Federal entities, please see <http://www.epa.gov/icr/icr.html> for more details.

**Baseline Data.** Establishing a credible baseline is critical for measuring the impacts of environmental innovations. Developing a baseline involves more than taking stock of current conditions; it lays the foundation for which all future environmental progress will be measured. Baseline data provide a frame of reference for the change that the innovation is initiating. Characterizing an appropriate baseline involves describing the conditions that prevail in the absence of the innovation by looking at measures, time frame, assumptions, and comparability. It is important to collect baseline data before the innovation is applied.

**Measures:** The innovation goals should be translated into measurable parameters, and appropriate metrics should express both baseline conditions and expectations of future changes. Appropriate measures to consider are environmental measures (e.g., particulate matter emitted), economic measures (e.g., tons of cement produced), and the inter-relation of environmental and economic measures (e.g., particulate matter emitted per ton of cement produced) when developing a baseline and planning for future reporting.

Baseline assessments are most helpful if innovation goals are addressed and well-defined at the beginning of the innovation. For example, if a facility's goal is to reduce Hazardous Air Pollutants (HAPs), it should clarify whether it is committing to reduce all HAPs, or it is focusing its efforts on reducing a subset of HAPs. Units of measurement and numeric expressions should be standardized early on. For example, mass units (tons, pounds) and actual number are appropriate measures to use. Similarly, measures for assessing economic activity should be standardized early on. The established environmental and economic baseline measures should be transparent and as simple as possible.

Normalizing measures: Normalizing environmental and economic data helps to organize data so that it remains relevant and meaningful in describing the innovation despite changes to processes or practices associated with the innovation. A common way to normalize data is on a per unit basis, or using a normalizing factor to adjust performance to the baseline year.

To normalize data on a per unit basis, simply divide the environmental quantity by the production measure for the same time period, which is typically one year (e.g., tons of emissions per tons of product annually). For example, if a facility produces 2000 tons of cement a year and 30 tons of air pollution, its per unit pollution is  $30/2000 = 0.02$  tons of air pollution per ton of cement.

When using a normalizing factor, the factor assigned to the baseline year is always one (e.g., Year 01). For example, in the first year of reporting and then in subsequent years, a facility divides its current year production by its baseline year production to derive the normalizing factor for that year. The facility then divides its actual environmental performance by the normalized factor to derive the normalized quantity. In Year 1, the facility produces 2000 tons of cement and 30 tons of air pollution. In Year 2, the facility produces 2300 tons of cement and 28 tons of air pollution. Its normalizing factor for the baseline Year 1 is 1.15 ( $2300/2000$ ). To calculate Year 2 tons of air pollution normalized to the baseline Year 1, divide the tons of air pollution produced in Year 2 by the normalizing factor to get 24.35 ( $28/1.15$ ) normalized tons of air pollution. The normalized quantity is less than the actual quantity in Year 1, reflecting that the facility performed proportionally better than its actual environmental statement given the increase in production in Year 2.

NOTE: If the innovation practitioner is trying to aggregate normalized data or compare normalized data across facilities—ensure that the basis for normalization is similar in order to be able to compare relative environmental performance.

Time frame: Another key decision to make when establishing a baseline is the appropriate period of time that characterized “current” or “normal” environmental and economic conditions. Using one year of recent data or an average of two years data is appropriate when:

- Economic activity is relatively steady over time;
- Recent and significant environmental technology upgrades mean that older environmental data are no longer applicable to future activity;
- Reporting on past performance related to the same innovation and is providing applicable economic data, essentially providing a longer time horizon for baselining; or
- Other facilities are involved in the innovation and may have one of the above circumstances.

It is important that environmental and economic data are reporting in the same time frame when establishing a baseline, as well as throughout the life of the innovation. Matching multi-year environmental data with single year economic data has the potential to skew the measurement of results.

Assumptions: The innovation practitioner should consider key assumptions behind the data collection. For example, if the innovation will be affected by impending regulations, the innovation baseline should account or include the effects of the new requirements in the baseline or explicitly identify the innovation impacts of the regulations. Criteria for making this determination could include the time frame of the

pending regulatory change compared with the time frame for the innovation, the level of certainty regarding the change in regulations, and the level of certainty regarding the effect of the change on the threshold for compliance.

**Comparability:** If the innovation practitioner is interested in comparing a series of like-innovations for transferability potential, then it is important to standardize the baseline as much as possible to allow for comparison of data. Specifically, individual projects that are part of a larger innovation initiative should ideally use the same measures, timeframes, and regulatory assumptions. Failing to standardize baseline conventions often sets individual projects down different paths in terms of data reporting and can lead to great difficulty in comparing the results of multiple innovations, and in analyzing factors that affect innovation success or failure. The innovation practitioner should consider the following baseline comparability factors whenever possible:

- Identify a reasonable compromise format that suits all innovations within a program.
- Data is provided in multiple formats—to better reflect individual innovation needs and one that is suitable for comparison and aggregation with other projects.
- Try to identify at the start of the innovation the components that may not be comparable to others due to existing baseline conditions.

A determination of what entities will be subject to the innovation allows the innovation practitioner to define the extent to which segments of the community will be affected by the innovation and to identify reliable databases from which to draw information regarding the number and size of such entities. Alternatively, the innovation practitioner may need to confer with councils, trade associations, or community groups to determine methods for gathering data regarding existing conditions. Despite efforts to use the best available data sources to establish a baseline analysis, the innovation practitioner should nonetheless identify areas of concern such as the consistency of variables over space and time, adherence to sampling protocols, sensitive populations, whether non-compliant or exempt entities are included, or any other limiting factors. In addition, there may be cases where the innovation is providing the data in an area where little existing data exists. If such is the case, if appropriate, surrogate data from research or data from similar experiments may be used. Depending on the innovation, the baseline may in fact be the absence of information, activities, or data.

### *Environmental Indicators*

5. For each environmental goal, what qualitative and quantitative **environmental indicators** (e.g., beaches closed, waters impaired, brownfields redeveloped) are being used to measure progress/impacts?
6. What is the **measurement approach** (e.g., modeling data, in-situ experiment, data extrapolation, real-time, one-time observations) that will be used to measure progress for each environmental goal?
7. For each environmental indicator, what is the **pre-innovation “baseline”** against which progress is measured (e.g., baseline is that 10 percent of beaches currently impaired—the innovation is to have zero impaired beaches in five years)?
8. How will pre-innovation “baseline” conditions for the **environmental impacts of third parties** (customers, suppliers, environmental quality trading partners, etc.) be established? How will changes be measure and non-innovation related changes controlled for?
9. For each of the environmental indicators listed above, what is the **schedule for data collection** (daily, weekly, yearly, etc.)?
10. According to the indicators listed above, what have been the **environmental impacts** of the innovation (e.g., 100 tons of volatile organic compounds emissions have been eliminated)? *Provide both qualitative and quantitative outcomes. The innovation may be of too recent origin for environmental impacts to be observable. Provide qualitative outcomes if possible—e.g., increase in senior management review, etc.*

**Environmental Results of the Innovation.** By comparing the pre-innovation baseline environmental results to the results during implementation or post-innovation, the practitioner can determine the net

change as a result of the innovation. This will allow for mid-course corrections, if necessary, or a determination as to whether the innovation had the desired outcomes.

An organizing table is provided in Exhibit 2. This model is neither intended to be comprehensive, nor anticipate every kind of innovation for which practitioners will want to assess environmental results. It should be modified to suit the innovation as the elements provided in the table are for illustration only.

***Data Sources, Collection, and Verifiability.*** It is recommended that the innovation team identify early in the process the data sources, collection and monitoring protocols, frequency of collection, persons responsible for data collection, and methods for data verification and quality control. By establishing procedures up front, it will be easier during implementation and at the evaluation phase of an innovation to assemble the proper data to determine credible environmental results.

### *Environmental Results*

11. To what extent are the **environmental impacts** of the innovation consistent with what was expected at the time of design and implementation?
12. Are **sufficient data available** to determine if the innovation has met its environmental goals (e.g., are the data qualitative or quantitative or both)?
13. To what extent **has the innovation been an improvement** over the prior/traditional approach with regard to:
  - i. Human health
  - ii. Organizational management
  - iii. Community based protection
  - iv. Quality of life
  - v. Ecosystem health
  - vi. Tribal management
  - vii. Environmental Justice communities
  - viii. Others
14. How are **environmental results verified**? Who is responsible for verifying results?
15. How often are environmental results verified?

## Exhibit 2—Environmental Results Table

**Innovation:** *Pallet Waste-to-Flooring Demonstration Project*

**Problem the innovation is trying to solve:** Demonstrate the technical and financial feasibility of recycling waste pallet wood into a value added flooring product

Project Objectives with Goals	Pre-innovation Base Statistics	Output Metrics	Sources of info and Calculations	Impact/ Outcome
Produce recycle pallet flooring Goals sq. ft	Pallet Hardwoods used in U.S: 4.5 billion board feet/yr (1998)	# square feet of flooring produced (from recycled pallets)	Production records	Natural resource conservation - Estimated percentage (increase compared to baseline) of hardwood tree conserve (trees/yr)*
		# trees not cut for flooring*	Calculation based on production records*	Percentage of trees saved from harvesting when compared to baseline.
Divert Pallet wood waste from landfilling/waste management methods	Over 305,000 tons per year of wood pallets are disposed in landfills in NC (1998)	# square feet of pallet boards diverted	Production records	Conservation of landfill/waste management capacity (tons/yr) compared to the baseline
		Tons of Pallet wood diverted from landfilling	Calculations based on production records	
Reduce greenhouse gases through carbon sequestration and landfill methane reduction.	No statistics.	MTCE	Model tools**	% GHG methane reduction MTCE

\*100 board ft/ 1 tree – USFS estimates based on trees 12” in diameter (DBH) with 2.5 16 foot long logs. Conversion factors: 0.625 board ft/ft^2 of finished flooring (for a 3/8” thick flooring product)

\*\*Metric tons of Carbon Equivalent (MTCE). Emission factors for wood: (Methane generation in landfill: 0.170 MTCE/wet ton) + (Carbon storage of wood: 0.21 MTCE wet ton) = 0.39 MTCE per wet ton. Source: SOLID WASTE MANAGEMENT AND GREENHOUSE GASES, A Life-Cycle Assessment of Emissions and Sinks, 2nd EDITION, EPA530-R-02-006, May 2002

SOURCE: Taken with Permission from EPA Region 4 and Office of Solid Waste and Emergency Response Innovation Pilots